Report on the State of the Polytechnic School in Paris. By an ENGLISH RESIDENT in Paris.

[*Read before the Statistical Section of the British Association, 27th August,* 1841.]

THE Polytechnic School was first established at Paris on the 28th of September, 1794 (7 Vendémiaire, An. III.), under the name of a Central School of Public Works, in virtue of a decree of the Convention, dated 11th March in the same year, for the formation of a commission of public works; and the opening of the establishment took place on the 21st of December of the same year. Its object was to supply young men for various branches of the public service, especially for the scientific departments of public works, artillery, engineers, &c.; all the public institutions for which had been entirely abandoned or suppressed in consequence of the revolution. Pupils were admitted between the ages of 16 and 20, after a previous examination in arithmetic and the elements of algebra and geometry; and the objects of their education were nearly the same as at the present day, only on a less extensive scale. The duration of their studies was three years. Part of the Palais Bourbon (now the Chamber of Deputies) was assigned for the use of the school, and a house was taken on the Quai Voltaire, (now No. 7,) for the use of some of the more promising pupils, who were then specially instructed and constituted chiefs of divisions for the superintendence and aid of their comrades. Among the professors who taught these select pupils occur the names of Monge, Barruel, Jacotot, Hachette, and Guyton. On the 21st of May, 1795, the day on which the school came into actual operation, 25 pupils d'élite were installed as chiefs of division, and their names merit commemoration. They were as follow:—Malus, Dupuis, Pattu, Fayolles, Hesse, Francœur, Bruslé, Patural, Callier, Biot, Bouvet, Lahure, St. Genys, Lancret, Hauterre, Eudel, Donop, Anselin, Cavenne, Debaudre, Riché, Lamandé, L'Evesque, Durostu, Lemaye and Durivan.

An annual allowance of 1,200 francs was made to each pupil during his residence of three years in the school: but as this was paid in paper (assignats) it was not worth more than 200 francs, and at last became entirely nominal. Pecuniary assistance was given from time to time by the Government, and even gratuitous distributions of bread had to be made, so deplorable was the condition of society at that melancholy period; but this was not sufficient, and during 1795, a considerable number of the pupils were obliged to leave the school and return home, not being able to support themselves.

In the same year, on the 1st of September, the school was re-organized, and assumed its present name of Ecole Polytechnique; the principal changes made in it being in the extension of the subjects of instruction. On the 16th December, 1799, a third organization took place; the number of pupils was fixed at 300; each pupil was allowed the pay of a sergeant of artillery for his support (360 francs a-year), and a sum of 20,000 francs was allotted from the public funds for annual distribution in the school. Great improvements were at the same time made in the administrative department of the school.

The fourth organization of the school took place on the 16th July, 1804, by order of Napoleon, when the school was transferred to its present locality, the buildings of the college of Navarre. At this period

the circumstances of France were so much improved, and the school had risen into such high repute, that, instead of an allowance being made to each pupil, an annual payment of 800 francs was required from them, and a sum of 42,000 francs was allowed for distribution among such as stood most in need of assistance. The opening of the school under the new regulations took place on the 22d of November, 1805; the strictly military character of the school was maintained, and the pupils received a flag on which was incribed,

"Pour la Patrie, les Sciences, et la Gloire."

This was a very flourishing period for the school, and the number of distinguished men who were educated in it established its character all over Europe.

The behaviour of the pupils during the two sieges of Paris, when they worked some guns on the heights of Belleville, Père la Chaise, and Montmartre against the allies, and their known attachment to Napoleon, gave a ready excuse to the government of Louis XVIII. for profiting by a breach of discipline to dissolve the school, on the 13th of April, 1816. It was re-organized by a royal ordinance, on the 4th of September, in the same year; but its military character was suppressed, a chaplain was attached to the establishment, and the uniform was abolished. The price of the annual payment was raised to 1,000 francs, as at present; and 24 bursarships, which still exist, were then granted to it from the coffers of the state. By subsequent ordinances, passed in 1822 and 1825, the military character of the school, and the uniform, were re-established; new courses of lectures were founded; the time of residence was abridged to two years; the system of public examiners was improved, and numerous other beneficial alterations were introduced.

The pupils of the school took a prominent part, as is well known, in the revolution of 1830, and aided greatly in overthrowing the government of the Bourbons. They subsequently became opposed to the policy pursued by the government of Louis Philippe, and in 1832 they made such a demonstration in favour of their principles, that the king disbanded the school. It was, however, immediately re-organized, (two partial changes having previously taken place, on the 13th November, 1830, and the 25th November, 1831,) and the Royal ordinance of 30th November, 1832, now constitutes the basis upon which the establishment exists. A further modification took place in 1836, but the alterations then effected referred merely to the suppression of political demonstrations, and to the repression of the spirit of disaffection to Louis Philippe, which still forms one of the strongest characteristics of the school. Professorships of English and German had been established since 1830, but in 1840, when a rupture with England became imminent, and public feeling in Paris and throughout France was greatly excited against Great Britain, the professorship of English was suppressed. At this period too, during the autumn of 1840, an unusual draft of pupils into the artillery and engineers took place, and orders were given for the admission of an extra number of pupils.

The system of instruction pursued in this school is almost entirely mathematical and scientific: the services for which the pupils are des-

tined being never lost sight of. They receive a certain degree of information in polite literature, but the amount bears a very small proportion to the remainder of their studies; and it is taken for granted that they possess sufficient knowledge in other branches before their admission. The main principle on which the system turns is that of perpetual partial examinations (called interrogations), which are made during the courses of lectures, and of general examination, enforced at the end of each scholastic year. These examinations of all kinds are very efficient, and are carried on with great impartiality. No respect is paid to mere personal rank in this establishment, but all the promotions and nominations are given entirely according to merit, and the spirit of competition thereby engendered is remarkably great. The preliminary examination is so extensive, and is carried into effect with such a degree of severity, that it ensures the admission into the school of none but young men of considerable talent and application, and it has the highly beneficial effect of immediately constituting the pupils into a corps d'élite. To be admitted into the Polytechnic School is one of the highest scientific distinctions which a young man can obtain in France: and to be drafted out of the school into any branch of the public service, is to ensure the future fortunes of the individual. It will be seen, in reference to the programmes of the courses of lectures, and the tables of study, that the subjects are far too numerous and important for more than a superficial knowledge of them to be imparted in the period allowed of two years: but it should be remembered that most of the pupils come already prepared with those subjects on the day of their admission; and that the studies of this school amount for them to little more than a perpetual series of examinations. In general it may be said that the average scientific acquirements of the mass of the pupils on leaving the school are equal to those of the majority of wranglers and senior optimes at Cambridge, while there are of course among their numbers distinguished men, who would compete with those at the head of the Cambridge Mathematical Tripos.

It will be observed, on a perusal of the regulations appended for the behaviour of the pupils, that they are kept under a strict system of military discipline, and as a body of young men, they are remarkable for their well-ordered and gentlemanlike deportment. The school contains no provisions for the religious instruction of the pupils, but the point of military honour is carried very high in it, and supplies the place of any ecclesiastical control. No distinctions are made on account of religious opinions; persons of any denominations are admitted, and in fact the pupils are left entirely to themselves in this matter. No bad consequences appear to ensue, judging from the conduct of the pupils in comparison with that of other young men in the metropolis; and cases of moral misconduct among them are exceedingly rare. They are always esteemed, and with justice, as the élite of the rising generation; and this is entirely attributable to the fundamental principle of the institution, that of working in earnest, and being kept to work with the greatest rigour.

Those pupils who do not pass the examinations at the end of the first year with credit, cannot go up into the second, and their chance of military or public promotion is thereby much diminished; but a similar

failure at the end of another year, or even neglect during the daily examinations of the lectures, would cause them to be immediately dismissed from the school. The places which they occupy in the examinations at the end of the second year determine their order of admission into the public service; and as only very few are annually rejected, it may be said that in general the success of a candidate in the final examinations is always followed by a commission in the artillery, the engineers, the bridges and highways, the navy, or some other branch of the public service.

The general course of studies is superintended by a Council of Instruction; and the whole system is subject to the constant supervision of a Council of Improvement. It is to the vigilance of these two bodies that the school mainly owes its efficiency. The principal officers of the school and other men of science form these councils, and the body of professors is always recruited by young men of the greatest promise, selected either from the school itself, or from the most distinguished scientific institutions of the country. A Council of Discipline watches over the internal regulations of the school, and the whole establishment is under the special jurisdiction and authority of the Minister of War.

The buildings of the school, and the adjacent ground allotted to it, (near the Pantheon) are very commodious and well arranged. The treatment of the pupils, though strict, is of a superior description; and, on the whole, it is by far the first educational establishment, excepting the Ecole Normale, which France possesses.

Regulations, &c.—By a law sanctioning the last Royal ordinance for the organization of the school, this institution is declared to be especially intended for the education of young men intended for the following branches of public service:—

Artillery, military and naval.
Engineers, military and naval.
Royal navy.
Army.
Engineers; hydrographers.
Staff corps, geodesic division.
Bridges, roads and mines.
Gunpowder and saltpetre manufactories.
Tobacco manufactories, and other public departments.

The course of study is limited to two years; but, although at the end of that time nearly all the pupils are sure to be placed in various public departments, the Government does not bind itself to provide for those for whom, if any, a sufficient number of places cannot be found. This case is however of extreme rarity, and in the autumn of 1840, when the preparations for war were making throughout the country, an extra number of pupils were drafted out of the school, before they had finished their studies, into the artillery, &c., and an extra number were ordered to be admitted as fresh pupils.

The price of the annual payment by the scholars is 1,000 francs per annum, payable quarterly in advance. There are 24 bursarships of 1,000 francs each, divisible into half bursarships, of which 12 are allotted to the department of the Minister of War, 8 to that of the Minister of the Interior, and 4 to that of the Minister of the Marine.

Conditions of Admission.—No pupil can be admitted into the school except after a public competition, notice of which is duly published by Government, and which is conducted by examiners in Paris as well as in certain towns in the departments.

No one can be admitted to this competition without having previously proved that he is French either by birth, or by naturalization; and that he is more than 16 years of age, but was less than 20 on the 1st day of the year in which the competition takes place. An exception to this latter regulation is made in favour of soldiers, who are admitted to the competition, provided they have not completed their 25th year. Documents, duly authenticated, must be produced in proof of the above qualification, and also a medical certificate that the candidate has been vaccinated, or has had the small-pox; that he has no contagious malady then upon him, and is not incapacitated by bodily infirmity or deformity, for the public service. The following is the programme of the examinations of ability for candidates for admission, taken from the official order of the Minister of War in 1841.

Programme of the Examination to be passed by the candidates for admission.—The knowledge required for admission into the Polytechnic School is as follows:—

I. Arithmetic (complete), including the theory of proportions, of progressions, of logarithms with the use of the tables, to seven places of decimals, and the explanation of the metrical system. II. Elementary geometry, including the proportions of spherical triangles. III. Algebra, including the resolution of the first two degrees, indeterminate equations of the first degree; the theory of fractional and exponential exponents; the demonstration of Newton's binomial theorem in the case only of positive integral exponents: the general composition of equations; Descartes' rules of signs; the determination of commensurable roots; the same of equal roots; the resolution of numerical equations by approximation, and the elimination of unknown quantities between two equations of any degree with two unknown quantities. IV. Plane trigonometry, with the use of the table of sines. V. Statics, demonstrated in the synthetical manner; composition and decomposition of forces and couples: reduction of a system of forces to a couple and to a single force; conditions of equilibrium of a solid body; centre of forces parallel and co-ordinate to that centre; determination of the centre of gravity of the triangle and pyramid; equilibrium of simple machines, the lever, simple pulley, compound pulley, inclined plane, wedge, wheel and axle, and the screw. VI. Complete discussion of the lines represented by equations of the first and second degree, with two unknown quantities; and the principal proportions of the conic sections. VII. The first elements of descriptive geometry, relative to the straight line and the plane. VIII. The making of architectural coloured drawings.

The candidates are further subject to the following trials:—

They will write a mathematical composition upon subjects given to them. They will have proposed to them an example of the resolution of a plane triangle, in order to show that they know the use of logarithmic tables to seven places of decimals. They will translate a passage from a Latin author of the same difficulty as that which is commonly given in the Rhetoric classes of colleges; and they will write an essay in French upon

a subject given to them. They will be required to write a legible hand and to spell correctly. They will copy an academic study of the human figure, shaded with the crayon, after a model to be given to them. They will make correct drawings from rough plans of descriptive geometry, upon the straight line and the plane, as well as a water-coloured architectural drawing. All these drawings must bear their own signature and the *visa* of the professor, together with the date of the *visa* for each.

Candidates are informed that *all* the parts of this programme are equally obligatory, and that none can be considered as merely accessory. Candidates are liable to be excluded from the list of admission if they have not satisfied the condition of examination in literature and drawing, although on all other points they may possess more knowledge than is here required.

Candidates are only examined in the subjects required by the programme, but attention will be paid to the knowledge they may possess of physics, chemistry, and the German language.

Further regulations of admission.—No pupil can obtain a bursarship or half bursarship, unless he forms part of the first two-thirds of the admission list, nor unless he addresses a demand for it at the time of inscribing his name.

Every pupil who does not present himself to the commandant of the school within the time specified in his letter of nomination, will be considered as having resigned. On arriving at the school the pupils will be subjected to fresh examinations, in order to prove that they are really the authors of the literary compositions, drawings, and plans which they have presented. In case of fraud being detected, the pupil committing it will be excluded. Every pupil is subject to a visit from the inspecting surgeons, to prove that he has no vice of conformation, nor any infirmity, which would disable him from being admitted to the lectures, or render him unfit for the public service, in case of his devoting himself exclusively to it. No one can be received into the school without immediately furnishing his articles of outfit,* nor without remitting to the commandant a written engagement, by which his parents, or other persons answerable for him, undertake to pay to the Receiver-General of the Treasury the sum of each pupil's annual payment, if the pupil has no bursarship, or of his half payment if he has a half-bursarship, every quarter in advance. This engagement, which must be legalised by the mayor or sub-prefect of the pupil's place of residence, must be made by the pupil himself, if he is legally of age and in enjoyment of his own property.

* Outfit list required to be furnished for each pupil.—
1 coat, full uniform, blue; 1 pantaloons, full uniform, blue; 2 undress frock coats, blue; 2 pantaloons, blue; 2 pantaloons, white cotton cloth; 2 pantaloons, unbleached cloth; 4 black stocks; 1 cocked hat; 1 foraging cap; 2 pairs yellow leather gloves; 1 sword belt; 3 pairs of sheets; 12 shirts, linen; 4 drawers; 6 caps; 12 pairs of socks; 18 handkerchiefs; 12 towels; 1 clothes bag; 1 blouse, for manipulations; 2 pairs of half-boots; 2 pairs of shoes; 1 case of mathematical instruments; 3 portfolios or cartons; 1 pocket-book; drawing saucers, &c.; inkstand, and minor chemical utensils, and other minor articles. All the above articles are furnished by the administration of the school, except the linen, which may be provided by the parents if they please. The cost of the whole outfit does not exceed 600 francs (£24). All articles worn out or lost have to be replaced by the parents or guardians of the pupil; and all payments are made quarterly and in advance.

List of Officers, Professors, &c. of the Polytechnic School for 1840.

Commandant.—Major-General Vaillant.

Sub-Commandant.—Colonel Espéronnier.

Inspectors of Studies.—Captain Gloux, Captain Demiau, of the artillery; Captain Descharières, Captain Bugnot, of the Engineers.

Captain-Instructor.—Captain Lenoble, Infantry.

Adjutants.—Chatenet, Marguerit, Allaire, Buffa, Cachardy.

Examiners.

Examiners of Admission.—Dinet, Lefébure de Fourcy, Bourdon, Comte.

Permanent Examiners.—Mathieu; one vacancy.

Temporary Examiners.—Demonferrand, Chevreul, Babinet.

Director of Studies.—Coriolis.

Professors, Under Examiners, and Masters.

Professors of Analysis and Mechanics.—Duhamel, Lionville.

Professor of Descriptive Geometry.—Leroy.

Professor of Physics.—Lamé.

Professors of Chemistry.—Gay Lussac, Pelouze.

Professor of Geodesy, Topography, and Machines.—Savart.

Professor of Architecture.—Reynaud.

Professor of French Composition.—Dubois.

Professor of German Composition.—Hase.

Professors of Drawing, for Figures and Landscape.—Steuben, Charlet.

Masters of Drawing, for Figures and Landscape—Dulong, Lalaisse, Danvin, Canon.

Master of Drawing for Topography, &c.—Brune.

Under Examiners for Analysis and Mechanics.—Comte, Sturm.

Under Examiner for Descriptive Geometry.—Olivier.

Under Examiner for Physics.—Bary.

Under Examiners for Chemistry.—Reynault, Péligot.

Under Examiner for Geodesy, Machines, &c.—Le Verrier.

Under Examiner for Architecture.—Jodot.

Under Examiner for Topography and Drawing.—Girard.

Under Examiner for French Composition.—Saint Hilaire.

Under Examiner for German.—Gauthier.

To the above should be added five assistant under examiners for analysis and mechanics, descriptive geometry, physics, and geodesy.

The administrative officers of the school consist of—

An administrator; treasurer; keeper of archives; librarian; physician; surgeon; keeper of stores; three conservators of scientific collections, &c.; six clerks, employed in various departments; a principal housekeeper for the linen, &c., and an inspector of buildings.

There are also various administrative officers, such as a solicitor, architect, assistant surgeons, &c. connected with the school, as well as a certain number of masters, exclusively privileged to give lessons in fencing, dancing, and music.

Salaries of the Officers, Professors, &c.—All the officers, including the commandant of the school, receive the full pay of their rank, and

have besides one-third more of their pay; the whole being paid them out of the funds of the school, which again are included in the budget of the Minister of War. The commandant further receives 4,000 francs per annum for household expenses; his house is large and handsome, and is furnished by the Government. The apartments allotted to the resident officers are in every way suited to their rank, and there are various perquisites of small amount attached to their offices. The professors do not reside.

The salaries of the professors, under examiners, &c. are as follows:—

	Francs.
Director of Studies	10,000
Examiners of Admission (each)	3,000
Permanent Examiners	6,000
Temporary ditto	2,500
Professor of Mathematical and Physical Sciences	5,000
Professor of Architecture	4,000
Professor of French and German	3,000
Professor of Drawing, and Topography (each)	2,000
Under Examiner of Mathematical and Physical Sciences	2,000
Under Examiner of Architecture	1,500
Under Examiner of Topographical Works	2,500
Under Examiner of French and German	1,500
Drawing Masters	1,200
Administrator	6,000
Treasurer	4,000
Surgeon, and Storekeeper (each)	3,000
Conservators of Collections	1,500
Adjutants	1,300

Number of Pupils, &c.—The total number of pupils in the Polytechnic School on the 1st of April, 1840, was 271, of whom 132 were in the first or senior division, and 139 in the second or junior division. Of those in the second division 4 had been directed to pass a second year in it, as not being sufficiently advanced to go up to the senior division; and of those in the first, 8 had been authorized to pass a second year in it, (or third year in the school) for various reasons. Besides the above, permission had been granted by the Minister of War to 10 young men, not pupils of the school, to attend the lectures of the first division; and to 16 to attend the lectures of the second division.

Out of the total number of pupils 2 were of British parents; 2 from the French colonies; 1 from Switzerland; 1 from Saxony, and 1 from Trebizond. Of the young men allowed to attend the lectures, not being pupils, 1 was English, 1 American, 2 Swiss, 3 Italian, 2 Greek, 1 Spanish, 2 Russian, 1 Norwegian, 1 Hessian, 1 Wurtemburger, 2 Portuguese, 1 Brazilian, and 8 French. Of the French pupils 56, or 26 per cent. were from the department of the Seine, and 13, or 5 per cent. from the department of the Moselle; the rest were from various other parts of the kingdom.

The following table exhibits the number of pupils who have been admitted into the several branches of the public service since the foundation of the establishment, and affords strong evidence of the advantage which the public has derived from the school:—

Services.	Before 1839.	In 1839.	Total.
Artillery (Marine)	58	..	58
Artillery (Military)	1,735	37	1,772
Staff Corps	31	3	34
Engineers (Marine)	123	4	127
Engineers (Military)	955	21	976
Engineers—Geographers . .	108	..	108
Engineers—Hydrographers . .	14	..	14
Royal Navy	114	4	118
Army	123	..	123
Mines	148	7	155
Roads and Bridges	812	43	855
Powder and Saltpetre Department	20	..	20
Tobacco Department	9	2	11
Total	4,250	121	4,371

On the General Regulations for the Behaviour and Discipline of the Pupils.—These regulations, which are in 66 articles, are exceedingly precise and severe, being framed on the strictest footing of military discipline, and calculated to enforce the most prompt and absolute obedience, under heavy penalties. Their main provisions are as follows:—

After unconditional obedience to every command of their superior officers is first laid down as the basis of the rest, the pupils are strictly forbidden to hold or form any society, or secret deliberation, or to take any step towards the same; they are not allowed to be present at any ceremony of any body or association without special permission from the Commandant; nor to print anything in any periodical publication; nor to introduce any book, printed paper, or drawing into the school without special leave; nor to play at any game of chance whatever; nor to smoke; nor to assault any of their comrades; nor provoke to duel (under pain of expulsion for both parties if a challenge be accepted); nor ever to appear without their uniform in or out of the school; nor to introduce any eatables, or drink, or chemical products within the walls; nor to bring in any parties whatever, not visited by the proper officer. The pupils are strictly tied down to salute their superior officers, and to behave to them in a becoming manner; and the rules for their behaviour in the lecture rooms and in the school generally, are very precise and rigid. The days on which they are allowed to go out in the town are Sunday and Wednesday, and no others; on the former of these days, from the termination of parade at $9\frac{1}{4}$ A. M. to 10 P. M., and on the second day from $2\frac{1}{2}$ P. M. to $8\frac{1}{2}$ in summer and 9 in winter. The parents and guardians of the pupils, or persons furnished with authority from them, are allowed to see the pupils in the parlour of the school on Sunday and Wednesday only, from 3 P. M. to $4\frac{3}{4}$ P. M. Any pupil remaining absent from the school three days, without communicating the cause to the commandant, ceases to belong to it, *ipso facto*.

The various punishments inflicted on the pupils are as follows:—

1. Private censure; 2. Public censure; 3. Notice in the order of the day; 4. Confinement to walls; 5. Confinement in the salle de police;

6. Imprisonment within the school; 7. Imprisonment in a military prison; 8. Expulsion.

The latter can only be inflicted by an order from the Minister of War himself, on a report from the commandant of the school.

The regulations which refer more especially to the conduct of the pupils in the lecture rooms direct that perfect silence and proper behaviour shall be maintained; that the pupils shall not copy from each other's works, nor give undue assistance to each other, and shall always give explanations of their inability to answer any interrogations addressed to them by the professors or examiners. They draw by lot, on first entering the school, for the seats they shall occupy in the lecture rooms, and always retain the same. Exact notes are kept of their behaviour as well as of their proficiency, and marks are allotted accordingly.

The pupils are divided into four companies, to each of which are attached, out of their own number, a serjeant-major, a serjeant-marshal (fourrier,) and six serjeants. These pupils wear on their uniform the same gold chevrons which distinguish the sub-officers of the same grade in the army. All orders of the officers are conveyed to the pupils of each company through these sub-officers, who are further responsible for the good conduct of their comrades, and are liable to be punished for them. The sub-officers have also to inspect the meat and provisions served out, to see that the weight and quality are correct; and to make certain returns of the movements of their company. They hold their rank only for one year, but they may be re-appointed, and their promotion is considered as a mark of honourable distinction.

PROGRAMMES OF THE COURSES OF LECTURES.

I. *On Analytical Mathematics, Calculus of Probabilities, and Mechanics.*

1. *Analytical Mathematics, Differential and Integral Calculus*.—First year.*—On functions in general. Relation between the increment of the function and increment of the variable. Differentials of simple functions and functions of functions. Functions, algebraical, logarithmic, &c.

Differentials of functions with several variables; implicit functions, &c.

Change of the independent variable. Taylor's series for functions of one variable, &c. Application of Taylor's theorem to the developement of a binomial, exponential, &c. De Moivre's formula. Maxima and minima of functions with one or more variables. Differential of the arc of a plane curve. Equations of the tangents and normals of plane curves; asymptotes, &c. Points of inflexion, &c.; circle of curvature; contact of plane curves; involutes and evolutes of curves; tangent and normal planes, &c.

Definition of the integral of a differential function. Methods of integrating rational functions, logarithmic functions, &c. Integration by series, &c.

Methods of finding the areas of plane curves and curves of double

* The principal points only are mentioned. In general the course comprehends a complete series of information on the subject, without going too much into minute details and problem work.

curvature; cubing of solids, &c.; solids of revolution, &c.; Limits, simple and double integrals.

Second year.—Differentiation and integration under the sign $\int$; determination of definite integrals. Conditions of integration for differential functions of the first order with several variables. Integration of the linear equation of the first order, and of the homogeneous equation. Particular solutions of differential equations of first order. Theorem on the integration of linear equations of any order. Elimination of variables between simultaneous differential equations. Integration by series of differential equations, &c. Elements of the method of variations. Elements of the calculus of finite differences, direct and inverse. Formulæ of interpolation. Theory of the curvature of surfaces. Radii of greatest and least curvature. Equation of lines of curvature.

2. *Elements of the Calculus of Probabilities and Social Arithmetic.*—General principles of the calculus of chances. Bernouilli's theorem. Probability of future events from antecedent observations. Mathematical angle. Application of ditto to lotteries, &c., tables of population, and mortality. Duration of life in various countries. Division of population according to age and sex. Influence of epidemic diseases.

On profit and loss of establishments depending on the probabilities of events: annuities, tontines, savings' banks, insurances, loans, &c.

3. *Mechanics. First year.—Statics.* Composition and equilibrium of any number of forces applied to the same point. Ditto, of parallel forces applied to given points. Momenta of parallel forces, &c.

Of the weight of bodies. Centre of gravity. Determination of ditto for the arcs and areas of curves, surfaces, and solids. Use of centre of gravity for measuring areas and volumes, &c. Attraction of spherical bodies formed of homogeneous layers on a material point, external or internal.

Dynamics.—Uniform motion; velocity; varied motion, &c.; *vis inertiæ.* Movements of heavy bodies in a vertical line, or on inclined planes, &c. Attwood's machine. Vertical motion of a heavy body in a resisting medium and *in vacuo.*

General equations of the movement of a point acted on by any force. Motion of projectiles *in vacuo.* Principle of areas in the motion of a single material point. Principle of live force in systems formed of points connected two and two, on curves or surfaces. Quantity of work. Motion of a heavy point on a given curve. Theory of the simple pendulum. Isochronism of oscillations in a cycloid. Kepler's laws. Consequence of these laws deduced from the equations of motion. Absolute and relative motion of two bodies attracting each other in the inverse ratio of the squares of their distances. Determination of the masses of the earth and the planets accompanied by satellites.

Throughout this course the professors require the pupils to make all their dynamical formulæ homogeneous, and to reduce them to numbers if demanded.

Second year.—Statics. Conditions of equilibrium of any number of forces applied to an invariable system; whether free, or retained by a point round which it can turn in any direction, or retained by an axis round which alone it can revolve.

Funicular polygons. Equation of the catenary: application to suspen-

sion bridges. Principles of virtual velocities in the equilibrium of a point, and of simple machines, &c.

Dynamics.—D'Alembert's principle for reducing questions of motion to questions of equilibrium. Motion of two heavy bodies connected with each other. Moment of inertia. Theory of the compound pendulum. Reciprocity of centres of oscillation and suspension. Motion of the centre of gravity of a system. Principles of live force. Of the collision of spherical bodies, elastic or non-elastic. Centre of percussion. Principle of the transmission of work deduced from the equations of live force, and application of it to machines.

Second year.—Hydrostatics. Principle of equal pressure in fluids. Propagation of external pressure through fluids to the sides of the vessel. Principle of virtual velocities verified in the equilibrium of these pressures. General equations of the equilibrium of a fluid subjected to the action of any forces. Centre of pressure. Equilibrium of a body plunged in a heavy fluid, or floating on the surface. Conditions of stability, &c.

Hydrodynamics —General equations of the movement of fluids subjected to the action of any force.

The general regulations stipulate that each lecture in all the above subjects, whether of analytical mathematics or mechanics, is to be preceded or followed by interrogations put by the professor. The last lectures of each part of the course may be employed in the general revision of the subjects explained in it. The professor, during the continuance of the course, gives examples to the pupils to be resolved by them, and converted, in their formulæ into numbers. The under-examiners question the pupils upon the subjects of the lectures three times a-week; and after the closing of the course of analysis, whether for the first or the second year, all the pupils are examined in the whole course by the professor and the under-examiners. The same takes place for the course of mechanics, &c.

II. *Descriptive Geometry and Analysis applied to Geometry.*

Descriptive geometry; on the straight line and the plane.

1st *Drawing Plan.*—1st *Q.* Through a given point in space, to draw a straight line parallel to a given straight line, and to find the real magnitude of part of this line.

2nd *Q.* Through a given point to draw a plane parallel to another given plane.

3d *Q.* To construct a plane passing through three points given in space.

2nd *Drawing Plan.*—4th *Q.* Two planes being given, to find the projections of their intersection.

5th *Q.* A straight line and a plane being given, to find the projections of the point where the straight line meets the plane.

3d. *Drawing Plan.*—6th *Q.* Through a given point to draw a perpendicular to a given plane, and to construct the projections of the point of meeting of the straight line and the plane.

7th *Q.* Through a given point to draw a straight line, cutting at right angles another straight line.

8th *Q.* A plane being given, to find the angles which it forms with the planes of projection.

4th *Drawing Plan.*—9th *Q.* Two planes being given, to construct the angle made between them.

10th *Q.* Two straight lines which cut each other being given, to construct the angle which they make between them.

11th *Q.* To construct the angle made by a straight line, and a plane given in position in space.

5th *Drawing Plan.*—12th *Q.* Two straight lines being given in space, to determine the position and magnitude of the line which measures their shortest distance.

Of Tangent Planes to Curve Surfaces.—6th *Drawing Plan.* 13th *Q.* To draw a tangent plane to a cylindrical surface: 1. Through a point on the surface. 2. Through a point out of the surface. 3. Parallel to a given straight line.

7th *Drawing Plan.*—14th *Q.* To draw a tangent plane to a conical surface, under the same conditions as before.

8th *Drawing Plan.*—15th *Q.* Through a point given on a surface of revolution, the meridian of which is known, to draw a tangent plane to that surface.

16th *Q.* Through a point given on a left-hand surface of the second degree, to draw a tangent plane to that surface. (The construction of this is not required.)

Intersection of Surfaces.—9th *Drawing Plan.*—17th *Q.* To construct the section made on a right cylindrical surface, by a plane perpendicular, to one of the planes of projection, &c., to draw the tangent to the curve of intersection, and to develope the cylindrical surface, &c.

10th *Drawing Plan.*—18th *Q.* To construct the intersection of a right cone, by a plane perpendicular to one of the planes of projection, tangent, and developement.

11th *Drawing Plan.*—19th *Q.* To construct the section made on the surface of an oblique cylinder, by a plane perpendicular to its edges, tangent and developement.

12th *Drawing Plan.*—20th *Q.* To construct the intersection of a surface of revolution with a plane, and the tangent to the curve of intersection.

13th *Drawing Plan.*—21st *Q.* To construct the intersection of two cylindrical surfaces and tangents.

22nd *Q.* To construct the intersection of two oblique cones and tangents.

14th *Drawing Plan.*—23rd *Q.* To construct the intersection of two surfaces of revolution.

Problems.—24th *Q.* To circumscribe a given pyramid in a sphere.

25th *Q.* To find a sphere touching four given planes.

15th *Drawing Plan.*—26th *Q.* To draw a tangent, parallel to a given plane, to a helix traced on a right cylinder with circular base.

27th *Q.* Through a point given on a spherical epicycloid, to draw a tangent to that curve.

28th *Q.* Through a given point, to draw a plane touching a sphere.

16th *Drawing Plan.*—29th *Q.* Through a given point, to draw a tangent plane to a surface of revolution.

Applications of Descriptive Geometry on Plans, with Notes and Numbers.—Notions of the manners of representing lines and surfaces by means of a single plane of projection, with notes and numbers.

17th *Drawing Plan.*—Different problems upon the above plans.

Shadows.—General notions on shadows.

18th *Drawing Plan.*—Shadows of a spherical niche.

19th *Drawing Plan.*—Shadows of a bridge. Shadows of an ellipsoid with three unequal axes, illuminated by a single point.

20th *Drawing Plan.*—Shadows of a Doric capital.

Linear Perspective.—General notions on perspective, and on the apparent outlines of bodies. Remarks on the vanishing point, or point of meeting of the perspectives of several parallel straight lines.

21st *Drawing Plan.*—Perspective of a pilaster placed in any manner with regard to the point of view.

22nd *Drawing Plan.*—Perspective of a vault with edges. Perspective of a winding staircase, or staircase with several flights.

23rd *Drawing Plan.*—Perspective of a fountain.

Stone Cutting.—24th to 30th *Drawing Plan.*—Various problems in stone-cutting for doorways, fitting in to sloping or circular walls, with various vaults; problems in vaulting, geometrical staircase, &c.

Timber Work.—The professor gives details on the manner in which the pressures are distributed between the various pieces of a timber roof, and on the dimensions which these pieces are required to have; and the pupils trace out a certain number of assemblages of timber work indicated by the professor.

31st *Drawing Plan.*—Different timber constructions.

32nd *Drawing Plan.*—Outline of a complete timber roof.

33rd *Drawing Plan.*—Right section of roofs.

34th *Drawing Plan.*—Winding timber staircase, with a rail.

Note.—All the drawing plans of the cutting of stone or of timber work are to be made with a metrical scale given to each pupil.

Analysis applied to Geometry of Three Dimensions.—Equations of the straight line and plane. Transformation of co-ordinates. Surfaces of the second degree, with or without centres. Diametrical planes, ellipsoid, hyperboloid, paraboloid, &c., with theorems depending on them. Circular sections, &c. Equations to surfaces, whether cylindrical, conoidal, of revolution, &c. Developable surfaces and left-hand surfaces.

Each lesson of this course is liable to be followed or preceded by an examination. Other examinations are also made by the under-examiners during the whole duration of the course; and, at the end of the course of applied analysis, the pupils undergo a general examination upon this course and upon descriptive geometry. Towards the end of the scholastic year, they are subjected to a second general examination on the other parts of the course of geometry.

III. *On Hydraulics, Astronomy, and Geodesy.*

Machines.—Object of machines, different kinds of movers, measure and action of force, definition of quantity of work, &c. Passive resistances, laws of friction, stiffness of cords, &c.

Principal elements of machines: transformation of movements, pullies,

cords, straps, toothed wheels, and friction of teeth of wheels; excentric wheels; fly wheels, regulating wheels, &c.

Animated movers: simple and differential wheel and axle, capstans, cranes, presses, differential screw, percussion press, &c.

Hydraulics.—Notions and formulæ of the flow of heavy liquids by small orifices, vena fluida, friction in tubes, &c.

Physical notions on the movement of water in the open air, influence of the bed of the stream, figure of the surface, velocity at different depths, mean velocity, &c. Impulse of a current on a plane.

Pumps, valves, pistons: La Hire's pump; Bramah's pump, and hydraulic press; resistance of pumps; hydraulic ram.

Draining machines: Schemnitz's machine, water-wheels, Archimedes' screw, Dutch screw, centrifugal machines, &c.

Hydraulic wheels in an indefinite current: wheels with paddles straight and curved, reaction wheels, turbines.

Windmills: construction of the arms, interior mechanism.

Steam engines in detail: duty and effect of machines, dynamic units, means of measuring the effects of machines, dynamometers, &c.

Note.—During this course the pupils are required to make a drawing plan of toothed wheels, shewing the number of their teeth, their dimensions, intervals, &c., to be determined according to an angular velocity, chosen by the pupils themselves. The plans are only so far to be made out, that it would be possible to make such wheels exactly from the descriptions afforded by them. They are also obliged to make complete drawings and plans of an hydraulic press; a drawing of some machine from a model, and a water-colour drawing of another machine.

Astronomy and Geodesy.—Principal formulæ of spherical trigonometry, measurement of angles, measurement of time, of watches and chronometers, spiral springs, escapements, compensations, &c.

Of the diurnal apparent movement of the heavens, and of the appearances of the heavenly bodies. The sphere; astronomical instruments; the terrestrial atmosphere; table of atmospherical refractions; method of least squares.

Of the sun and its apparent movements; of astronomical longitude and latitude; right ascension and declination; the calendar; cause of the inequality of days; the seasons, &c.

Of the moon and her phases, parallax, librations, and eclipses.

Of the stars and their movements; precession of the equinoxes; nutation of the earth's axis.

Movement of the earth; movement of the planets; satellites of the planets.

Velocity of light, aberration, parallax of the sun from the passages of Venus, &c.

Comets, their orbits, &c.

Effects of gravity in producing the celestial movements.

Physical cause of the spheroidal flattening of the earth; use of the pendulum as a measure of weight; laws of gravity at the earth's surface; tides; influence of the sun and moon; tide tables.

Latitude and longitude, means of observing and determining.

Solar heat: variations of heat experienced at the same spot on the earth's surface, limits of perpetual snow, temperature of mines, &c.; dif-

ference of temperature in the northern and southern hemisphere, temperature of the ocean, &c.

Winds: monsoons, &c.; currents of the ocean.

Phænomena of terrestrial magnetism: magnetic lines on the earth's surface; intensity of magnetic forces.

Measurement of altitude with the barometer; diurnal variations of the barometer.

Geodesy.—Geodesic instruments; repeating and reflecting circles; figure of the earth; formation of a system of spherical triangles; measurement of the angles; reduction of the angles; formulæ and methods for the calculation of triangles; measurement of basis, of latitudes and azimuths.

Dialling: projection of maps applied to the methods used in the war department; drawing plans of ditto.

Each lecture in the above course is liable to be preceded or followed by an examination; and the professor, during the course, is to make at least as many examinations of the pupils in his own rooms as there are lectures. At the end of the course on machines, the pupils are examined by the professor and under-examiner on all the subjects comprised in it. A second general examination is made after the course of geodesy.

IV. *On Topography.*

The exercises of topographical drawing, for the second division of the school, are preceded by a lecture from the professor of geodesy, to acquaint the pupils with the geometrical principles adopted in executing topographical maps. The description and use of the instruments required are also explained by this professor. The pupils are exercised in making drawings of this kind throughout the two years, and their drawings are of two descriptions. The first have to be made from a drawing representing the conformation of the ground, by a system of curves of equal elevation, that is to say, by equidistant horizontal sections. In the second, the conformation of the ground has to be shewn by linear shading, proportioned in length to the elevations. Their intervals and thickness have also to be combined in such a manner as to give an exact idea of the ground when illuminated by a vertical light. On each of these drawings the objects of detail, such as rocks, rivers, limits of cultivation, trees, houses, roads, &c., are to be expressed by lines indicating their horizontal projections.

In the lettering and other particulars, the pupils have to follow the methods used in the war department. Their drawings are exhibited in the school, and their merit is determined at the end of the year.

For the drawing of the human figure and for landscape drawing, all the works executed by the candidates for admission into the school are judged of by a commission of the drawing masters attached to the establishment, and the result of their decision is submitted to the director of studies. This latter officer divides the new pupils into two classes, equal in number and skill in drawing, according to the opinions of the above-named masters; and each class is then placed under the exclusive direction of the same drawing master for the whole duration of the course of drawing, and for all kinds of it. Landscape drawing in the

second year is executed in water colours, and marks of merit are given to each drawing according to its deserts.

V. *On Architecture.*

1st Part.—General principles of the construction of edifices; system of projection for the representation of edifices; materials—stone, bricks, mortar, &c.

Foundations.—Construction and decoration of walls, columns, doors and windows, vaults, &c.; ditto in wood floors, roofs, &c.; ditto in iron, isolated supporters of floors, &c. Staircases in stone, wood, iron, &c.; chimneys, wainscoting, frame work, pointing, &c.

2nd Part.—General principles of composition applied to porches, porticos, stairs, saloons, courts, gardens, fountains, &c.

3rd Part.—Composition applied to edifices, schools, barracks, hospitals, prisons, arsenals, triumphal arches, gateways, light-houses, dwelling-houses, &c.

The pupils are required to draw, during the lecture, the sketch traced by the professor on his lecturing board, and to perform other similar exercises. After the termination of the course, there are four general competitions for the construction of edifices, according to the marks obtained in which the pupils are classed in this department at the end of the year.

The pupils are required to make four water-colour architectural drawings the first year, and three the second; the choice of subjects being left to the professor.

VI. *On Physics or Natural Philosophy.*

First Year.—1st Part.—General properties of bodies; extent; impenetrability, weights, and densities. Transmission of pressure in liquids; conditions of equilibrium of ditto. Elastic fluids, Mariotte's law, &c. Of the barometer, and other instruments for measuring the weight and pressure, &c. of the air. Specific gravities of bodies, compressibility of solids, balance of tension, &c.

2nd Part.—Thermometers: dilation of solids, liquids, gases, &c.; radiating heat, laws of, and experiments upon, &c. Conductibility of solids, liquids and gases; specific heat of ditto. Of steam; relation between elastic force of steam and its temperature. Latent heat of liquids and vapours; law of cooling in vacuo and in elastic fluids, &c.

3rd Part.—Constitution of the atmosphere, hygrometry, hygrometrical equilibrium; ditto instruments; ditto tables. Evaporation; clouds, rain, dew, &c.

4th Part.—Molecular attraction; cohesion, laws of, and proportions of matter; adhesion of disks to surfaces of liquids. Capillary attraction; attraction and repulsion of floating bodies.

5th Part.—Electricity: laws of conductibility, electrical machines, power of points, &c.; theory of latent electricity, the condenser, Leyden jar, electric batteries, &c. Of atmospheric electricity, lightning conductors, &c. Of the voltaic pile, the galvanometer, &c., chemical effects and laws of, modifying circumstances, &c.

Second Year.—6th Part.—Magnetism: magnetic phænomena, direction of magnetic needle, dipping needle, &c. Different methods of

magnetising the needle, law of magnetic attractions and repulsions, action of electric currents on magnets, &c; mutual action of electric currents, solenoids, &c. On magnetism produced by electricity; on electricity developed by heat; thermo-electric phænomena.

7th Part.—Acoustics: production and propagation of sound in gases, liquids, and solids; velocity of sound; reflexion of ditto; intervals of ditto. Measurement of numbers of vibrations, longitudinal vibration of cords, theory of musical instruments, nodal surfaces of solid bodies in vibration, &c.

8th Part.—Optics: ray of light, umbra and penumbra, laws of intensity of light, absorption of ditto, photometers; reflexion of light, foci of ditto, images formed by ditto; simple refraction, the mirage index of refraction, foci of refraction, foci of lenses, optical centres of lenses, images formed by refracted rays; aberration of sphericity of colours considered in light, unequal refrangibility of coloured rays, measurement of dispersion, &c. The rainbow: determination of diameter and width of arcs. Of achromatism: construction of achromatic objective glasses. Description of the eye: theory of vision, optical illusions, &c.

Optical instruments: microscopes, simple and compound; camera obscura, Daguerrotype; camera lucida; telescopes: Galileo's ditto, Newton's ditto, Gregory's ditto; the Heliostat. Double refraction: law of extraordinary refraction in crystals of one axis; crystal micronometer. Polarization of light; phænomena of interferences; diffraction; coloured rings.

9th Part.—Rays of heat of different kinds; diathermanic bodies; distinction between luminous heat and dark heat; phosphorescence. Refraction of heat: maximum of colorific action of the solar spectrum; polarization of heat.

Note.—During the whole of this course, the under-examiner makes two examinations a-week for each division, and explains the philosophical instruments to the pupils,

VII. *On Chemistry.*

First Year.—General considerations on the nature of bodies; molecular attraction; phænomena of chemical re-actions. Hydrogen, oxygen, azote, atmospheric air. Chlorine, bromium, iodine, fluorine, sulphur, selenium, tellurium, phosphorus, arsenic, carbon, borium, silicium, potassium, sodium, &c. Water: separation of bodies in ditto, deposits in steam boilers, analysis and synthesis of water, air dissolved in water, gases combined, &c. On natural substances, acids, bases, &c.; hydrochloric acids and other combinations of hydrogen; combinations of azote, chlorine, iodine, &c., with oxygen. Fabrications and use of sulphuric acid. Combinations of selenium, phosphorus and arsenic with oxygen; oxide of carbon, carbonic acid, liquefaction and solidification of ditto. Alcaline and earthy bases, ammonia, potassium, soda, alum, magnesia, barytes, strontian, lime, &c. Phosphoretted hydrogen; Graham and Rose's experiments on this gas. Combination of carbon with hydrogen, gas for lighting oxygenated water, &c. On salts: general properties of chlorures, sal ammoniac, sea salt, and rock salt. On bromures, iodures, fluorures, &c. Sulphurated compounds, chlorates, bromates, nitrates, &c. On gunpowder; its manufacture, analysis, &c. Nitrites, sulphates,

hyposulphates, sulphites, hyposulphites, &c.; phosphate, phosphoric acid, &c.; phosphites, arseniates and arsenites, carbonates, borates, silicates, &c.; ammoniacal salts, potash, soda, &c.

Second Year.—On metals; their natural state, extraction, &c. On their oxydes, sulphures, salts, &c. On alloys used in manufactured metals: chromium, manganese, zinc; iron, metallurgy of iron, cast iron, steel, &c.; cobalt and nickel, tin, antimony, lead, copper, silver, platina, gold, &c. Mortars, cements, hydraulic cements, bricks, pottery, glass, enamel, &c.

Organic Chemistry.—General considerations on organic substances, analysis of ditto, classification of ditto. Organic acids, oxalic acid, acetic ditto; vinegar from wine, ditto from wood; formic acid, lactic, tartaric, malic, benzoic, and other acids. Pyrogenic acids, vegetable alkalis, morphine, sulphate of quinine, sugar, starch, dextrine, fabrication of beer, gums, &c. Fermentation of wine, cider, &c. Alcohol; etherification; sulphuric, oxalic, &c., ethers. Vegetable and animal greases, stearine, oleine, oils, &c. Soap-making, candle-making, &c. Essential oils, resins, &c.; cyanogen, hydrocyanic acid, &c.; chlorures of cyanogen, &c.; percussion powder, &c.; gelatine, fibrine, albumine, caseum, mucus, blood, &c.; urine, urinary calculi, bile, bilious calculi, the brain and its secretions. Colouring matters, dyeing, &c. Phænomena of respiration and germination.

Programme of the Chemical Manipulations performed by the Pupils of the Second Division.

First Year.—1st *Manipulation.* Preparation of oxygen; combustion of carbon, sulphur, &c., in oxygen; preparation of hydrogen. 2nd. Action of carbon on gases, colours, putrescent matter, &c.; preparation of bi-carbonated hydrogen, &c. 3rd. Purifications of sulphur, ditto chlorine, action on metals, &c. 4th. Preparations of iodine, ditto of azote. 5th. Analysis of air by phosphorus and by hydrogen; distillation and decomposition of water. 6th. Carbonic acid, decomposition, &c.; boric acid, &c. 7th. Protoxide of azote, azotic acid, effects on metals, &c. 8th. Sulphurous acid; hyposulphuric acid; sulphuric ditto. 9th. Chlorhydric acid, fluoric acid, engraving on glass, &c. 10th. Preparation of ammonia, ammoniacal salts, &c. 11th. Preparations of iron, zinc, tin, copper, lead, &c.; oxides of ditto, solders, bronze, &c. 12th. Oxides of aluminium, magnesium, antimony, &c.; hydrates of ditto. 13th. Fusion of sea salt; chlorures of aluminium, iron, tin, mercury, &c.; iodure of lead. 14th. Fabrication, tempering, &c., of steel; sulphures of potassium, iron, mercury, &c.; decomposition of salts by metals, crystallization of salts, &c.

First Division.

Second Year.—1st *Manipulation.* Preparation of chromate of potassium, barytes, &c.; chromate of chlorure of chrome, &c. 2nd. Protochlorure of mercury, analysis of manganese of commerce, combustion of zinc, sulfure of zinc, &c. 3rd. Pyrophoric iron, perchlorure of iron, decomposition of sulphate of iron, separation of iron from manganese, &c. 4th. Oxyde of nickel, peroxide of tin, &c. 5th. Preparation of antimony by means of sulphur, oxide of antimony, sub-nitrate of bismuth,

&c. 6th. Purple oxide of lead, nitrate of lead, &c. 7th. Nitrate of copper, deutoxide and protoxide of copper, analysis of latten, bronze, &c. 8th. Preparation of protochlorure and perchlorure of mercury, nitrate of silver, chlorure of silver, &c. 9th. Analysis of gunpowder, essay of iron and copper ore, &c. 10th. Oxalic acid: acetate of copper and lead, citric and tartaric acids, preparations of, &c. 11th. Emetic: benzoic acid, mucic acid, succinic acid, &c., preparation of, &c. 12th. Preparation of quinine: potato-starch, transformation of starch into sugar, preparation of beetroot sugar, and pectic acid. 13th. Alcoholic fermentation: preparation of sulphuric ether, oxalic ether, &c. 14th. Preparation of stearic acid; soap, analysis of, &c.; Prussian blue, fibrine, &c. 15th. Dyeing processes: indigo, Brazil wood, chrome yellow, Saxon blue, wood, vitriol, &c.

The manipulations last from six to seven hours each, and are made to coincide with the lectures in chemistry, so as to serve for examples. Each manipulation is preceded or followed by an examination; and during the course there are two weekly examinations by the under-examiners. The under-examiners attend from time to time, in the manipulation laboratories, to give instructions. At the end of the course, a general examination is made by the professor and under-examiners.

Programme of the Course of Lectures in French Composition and Literature.

This course has two objects:—I. To exercise the pupils in composition. II. To give them the true principles of taste by the study of the great writers of the last three centuries. The subjects of composition include historical, literary, and moral questions, explained *vivâ voce* by the professor, who afterwards corrects the exercises brought to him in the lecture-room, and assigns marks of merit to each performance. The second part of the course includes:—I. The explanation of the rules of composition; and, II. The comparative study of the great writers of the epoch above mentioned. The professor gives marks for the exercises, which count at the end of the year.

The programme of the course of lectures in the German language is similar in effect; only the first part of the course includes the more elementary parts of the German grammar, and exercises in pronunciation take place, as well as constant *vivâ voce* examinations. Marks of merit are given in this as in the other course (of French).

"*General Observations on the Conducting of the Courses of Lectures.*"—"Interrogations upon the subject of each course may be made at any time during the delivery of the lectures; and the professors have the right of being present at the interrogations made by the under-examiners. After each lecture and partial examination, the professors and under-examiners give marks according to the merits of the pupils; these marks are transmitted to the director of studies, together with a note on the subject of the lecture. During the second year, the interrogations or examinations are to be made in such a manner that it may be ascertained whether the pupil recollects the subjects of the first year, or has forgotten them. In each year the pupils of the first division receive independent lectures on anatomy and physiology, in order to give them

some elementary notions of the structure and principal functions of the human body. They also receive, during their hours of recreation, lectures on various of the useful arts, but attendance upon these is not compulsory. During the second year, the pupils are taken to visit several large manufacturing establishments in various branches."

Daily Distribution of Studies, &c.—The hours for rising are 6 o'clock from 6th November to 8th May, and half-past 5 from 8th May to the end of the scholastic year. The roll is called over at half-past 6 in the first period and 6 in the second. From 7 to 8 is a period of *étude libre*, during which period alone of the day the pupils are allowed to occupy themselves with drawing, if they choose—not including the drawing lectures. From 8 to 9 is allowed for breakfast. From 9 to 2 is devoted to the more important lectures and examinations of each period. From 2 to 3 dinner. From 3 to 5 is given to various exercises, fencing, dancing, military drill, music, &c. At this time of the day, too, the library is open to the pupils. From 5 to 9 is a period of *étude libre*, and of lectures and examinations in the less important subjects, drawing, French, German, &c. From 9 to half-past 9 supper, during the winter portion of the year, or from half-past 8 to half-past 9 during the summer portion. The roll is always called over at half-past 9 in the bed-chambers, and lights are extinguished at 10 on week-days or half-past 10 on Sundays. On Sundays, after breakfast, a general military parade is held from 9 to 10, after which time the pupils are allowed to go out till 10 at night; and lights must be extinguished in the bed-chambers by half-past 10. Dinner on Sundays is at half-past 2, and the library is open from half-past 9 to half-past 2. On Wednesdays the pupils are allowed to go out from 3 to 9.

General Examinations.

At the end of the scholastic year the pupils are all subjected to four general examinations, distinct from the ordinary examinations (*Interrogations Générales*), which are divided as follows:—

Second Division.

1st *Examination.*—Analysis; ditto applied to geometry; mechanics.
2nd *Examination.*—Chemistry.
3rd *Examination.*—Physics.
4th *Examination.*—Descriptive geometry and its applications; application of algebra to surfaces of second degree, &c.

First Division.

1st *Examination.*—Analysis; ditto applied to geometry; mechanics; effect of machines; probabilities, &c.
2nd *Examination.*—Chemistry.
3rd *Examination.*—Physics.
4th *Examination.*—Geodesy; description of machines, architecture, &c.

Table of the Distribution of Courses of Lectures and Examinations (Interrogations Générales).

For the Second or Junior Division (First Year of Study).				*For the First or Senior Division (Second Year of Study).*			
Courses.	Number of Lectures.	Time of Lectures.	Time of Examinations.	Courses.	Number of Lectures.	Time of Lectures.	Time of Examinations.
Analysis and Geometry	48 } 76	9 Nov. to 28 Feb. / 21 March to 23 May.	16 March to 20 March. / 9 June to 13 June.	Analysis and Geometry, Probabilities	35 } 41 } 76 / 6 }	7 Nov. to 8 Feb. / 7 March to 26 May.	2 March to 6 March. / 15 June to 19 June.
Statics and Dynamics	28			Mechanics	35 }		
Descriptive Geometry	66 } 80	1st Part. 8 Nov. to 13 Feb. / 2nd Part. 2 March to 10 June.	25 Feb. to 29 Feb. / 6 July to 10 July.	Machines	28 } 62	7 Nov. to 8 Feb. / 29 Feb. to 27 June.	24 Feb. to 28 Feb. / 13 July to 17 July.
				Geodesy	34 }		
				Physics	30	6 Nov. to 10 June.	29 June to 3 July.
Analysis applied to Geometry	14	13 Nov. to 7 Feb.	25 Feb. to 29 Feb.	Chemistry	36	8 Nov. to 10 July.	20 July to 25 July.
Physics	30	11 Nov. to 1 June.	22 June to 26 June.	Architecture	34	11 Nov. to 29 June.	8 June, &c.
Chemistry	36	6 Nov. to 8 July.	20 July to 25 July.	German	30	12 Nov. to 2 June.	9 June, &c.
French Composition	30	7 Novr to 4 June.		Topographical Drawing	29	11 Nov. to 25 May.	
Topographical Drawing	29	19 Dec. to 2 July.		Drawing (Figures and Landscapes)	52	7 Nov. to 4 May.	
Drawing (Figures and Landscapes)	51	8 Nov. to 8 May.				1st Part. 11 Nov. to 25 Nov. / 2nd Part. 7 May to 16 July.	
Water-colour Drawing	18	1st Part. 7 Nov. to 28 Nov. / 2nd Part. 12 May to 26 June.		Water-colour Drawing	17		